OLED microdisplays for augmented reality applications

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1. Introduction

Microdisplays are widely used in head mounted displays (HMDs), electronic viewfinders (EVF) and other near-to-the-eye visualization systems. An overview about the different technologies and applications can be found in [1]. Due to their superior image quality, power efficiency and compactness, emissive type microdisplays based on OLEDs have been strongly increasing their market share for these applications. With the potential and recent advances of wearable Augmented Reality (AR), OLED microdisplays start to enter this application. We will limit here to applications we qualify as wearable AR as defined in Figure 1.

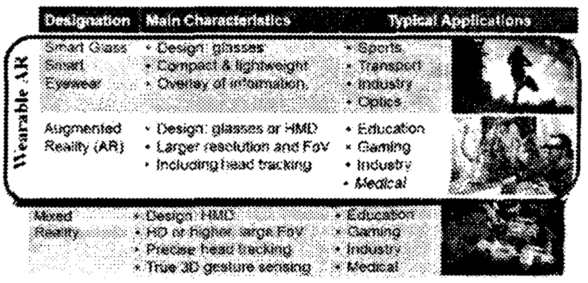

Figure 1: Definition of wearable Augmented Reality

2. Objective

Objectives are to review requirements for microdisplays and related optical systems used in wearable AR, to benchmark them against the performance of different microdisplay technologies, and to present solutions based on our OLED microdisplay technology.

3. Requirements

The general requirement for wearable AR are shown in Figure 2 below:

Design Invisible Technology Curved shape glasses	Use Lightweight & comfortable Operating time > 10Hrs
No Compromise on Optical Quality Real see-through No light leakage	Good Visibility of Display Overlay Brightness Large eye box

Figure 2: General requirements of wearable AR

From this, we can derive requirements for both the optical see-through system and the microdisplay.

One key element in the consideration here is power efficiency, as only a power efficient system can achieve low weight, compactness, and reasonable operating times. Another one is the emphasis on the optical quality, which means that no obstructive elements or parasitic light leakage is allowed that could impact the view of the user.

4. Main outcomes

A comparison between different technologies for the optical system and the microdisplay will be outlined in the presentation. As an example, Figure 3 shows a comparison between OLED and micro-LED based microdisplays.

	OLED	µLED
Maturity	**High:** in volume production	**Very low:** monochrome prototypes
Image Quality	**High**	**Major challenge:** pixel-to-pixel uniformity, color
Power efficiency	**High**	**Challenge** for small pixel size
Brightness	**High** for monochrome, **Medium** for full color, But short term potential for significant increase	**Very High** for monochrome still **to be demonstrated** for color
Cost	**moderate**	**Major challenge:** cost of LED wafer, complex hybrid process, yield

Figure 3: comparison of OLED vs micro-LED based microdisplays

Considering both technical performance and technology maturity it comes out that only systems based on OLED microdisplays combined with optical systems of the free-space optics type can fulfil the above requirements. In future, also some type of waveguide type optics might be used. Figure 4 shows some examples of high brightness OLED microdisplays for AR applications.

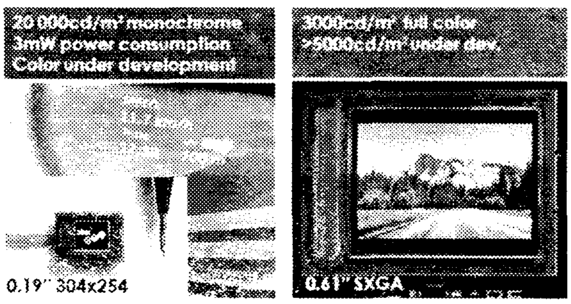

Figure 4: Two examples of high brightness microdisplays for wearable AR

5. Acknowledgements

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6. References

[1] G. Haas, "Microdisplays for Augmented and Virtual Reality," SID 2018 Symposium Digest of Technical Papers, p. 506, 2018